A reassessment of the fossil goose *Anser scaldii* Lambrecht, 1933

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Received 27 November 2007

The name *Anser scaldii* was first used by Van Beneden (1872) in a brief text that read 'Nous avons recu un humérus dans un parfait état de conservation, trouvé dans le crag, à Anvers'. The name was also used by Van Beneden (1873), but in both instances it is a *nomen nudum*. The name was made valid for the purposes of nomenclature by Lambrecht (1933: 368) when he entered *Anser scaldii* Van Beneden, 1872, with the following description and information: 'Humerus typisch anserin, von der Größe von *Tadorna casarca*. Länge 129 mm. Material: Humerus im Mus. Bruxelles. Alter und Fundort: Obermiozän (Bolderian), Antwerpen. Etymologie: Artname nach der Schelde: Scaldia.' At the same time he mistakenly gave the original combination as *Anas scaldii* Van Beneden 1872, which error was perpetuated by Gaillard (1939), Brodkorb (1964), Howard (1964), and Bochenski (1997), as noted by Mlíkovský (2002: 125).

The statement by Lambrecht that this fossil is of similar length to humeri of *Tadorna* prompted Worthy *et al.* (2007) to suggest that *Anser scaldii* may have a bearing on the evolution of Tadornini in Europe. Accordingly, we re-examined the holotype in the Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium, to ascertain its relationships and its significance in Anseriform evolution.

Abbreviations

Institutions—ANWC, Australian National Wildlife Collection, CSIRO Sustainable Ecosystems, Canberra, ACT, Australia; BMNH, Natural History Museum, London, UK; CM, Canterbury Museum, Christchurch, New Zealand; IRSNB, Département de Paléontologie, Institut royal des Sciences naturelles de Belgique, Brussels, Belgium; MNZ, Museum of New Zealand Te Papa Tongarewa, Wellington, New Zealand (formerly National Museum of New Zealand, Dominion Museum, and Colonial Museum); MV, Museum Victoria, Melbourne, Australia; SAM, South Australia Museum, Adelaide; SMF, Forschungsinstitut Senckenberg, Frankfurt-am-Main, Germany; USNM, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA.

Materials and Methods

A cast was made of the fossil by R. Smith of the Royal Belgian Institute of Natural Sciences and provided to THW for study in Australia. Comparisons were made with recent skeletons of a wide range of waterfowl taxa in the SAM. Additional observations were made on specimens from the collections of ANWC, CM, MV, MNZ and USNM. Measurements were made with dial callipers and rounded to 0.1 mm. Anatomical nomenclature of specific bone landmarks follows Baumel & Witmer (1993) with English translations, or names follow Howard (1929), thereafter.

Comparative material used in this study.—Tadorna tadornoides (Jardine & Selby, 1828), Australian Shelduck: SAM B39873, female; SAM B39591, male. *T. variegata* (J. F. Gmelin, 1789), Paradise Shelduck: MNZ 25139, 25669. *T. ferruginea* (Pallas, 1764), Ruddy Shelduck: SAM B.38602. *T. tadorna* (Linnaeus, 1758), Common Shelduck: MNZ 12280; MV B25679;

ANWC 22408, male. *T. radjah* (Lesson, 1828), Radjah Shelduck: MNZ 26206, 26207; ANWC 22411, male. *Alopochen aegyptiaca* (Linnaeus, 1766), Egyptian Goose: ANWC 22239, male; BMNH 1930.3.24.217, unsexed; MNZ 24283; MV B25678. *Chloephaga picta* (J. F. Gmelin, 1789), Upland Goose: BMNH 1860.11.4.15. *C. poliocephala* P. L. Sclater, 1857, Ashy-headed Goose: MV B13714, female. *C. hybrida* (Molina, 1782), Kelp Goose: MV B13227, male. *Branta canadensis* (Linnaeus, 1758), Canada Goose: MNZ 23745, 26738–41; SAM B31086; MV B6364, male. *B. bernicla* (Linnaeus, 1758), Brent Goose, MV B5156; eastern USA, five males: USNM 561418, 501611, 553108, 500361, 492443; five females: USNM 561415, 561417, 561016, 561416, 561028; Europe: SMF 452, 1940, 4394, 6562, female. *B. leucopsis* (Bechstein, 1803), Barnacle Goose: USNM 246190, 343808, 489420, SMF 619, SMF 6231, female. *Anser brachyrhynchus* Baillon, 1834, Pink-footed Goose: MV B25672. *A. caerulescens* (Linnaeus, 1758), Snow Goose: SAM B36868, female. *A. anser* (Linnaeus, 1758), Greylag Goose: MNZ 20812, 24519. *A. erythropus* Linnaeus, 1758, Lesser White-fronted Goose: IRSNB 22.431 (IG 18.059). *Cygnus atratus* (Latham, 1790), Black Swan: MNZ 15266, 15267, 17250; SAM B46110, male.

Results

Holotype.—IRSNB Av69, a right humerus, reassembled from three pieces, complete except for some erosion to the rim of the deltoid crest. The bone was separated at the reassembly point for this investigation and it was determined to lack the infilled sediment of other fossil bones from the Bolderian, and instead had been filled with plaster. The bone appears relatively fresh and unmineralised.

Measurements.—Length 129.7 mm, maximum proximal width from dorsal tubercle 27.2 mm, mid-shaft width 8.5 mm, maximum distal width 17.7 mm.

Locality.—Antwerp, Belgium; 'trouvé dans la nouvelle enceinte d'Anvers, deuxième section, en Avril 1864' (Van Beneden 1873: 372).

Stratigraphy/Age.—Dollo (1909) listed *A. scaldii* in the fauna of the marine sands of the local Bolderian Stage, then assumed to be Upper Miocene but now considered to be early to middle Miocene (Louwye *et al*. 2000, Laga *et al*. 2001). Brodkorb (1964) modified this to the 'Anversian black sands'. Fossils from the different layers of the Bolderian regional stage in the Anvers area are always dark grey to black (M. Bosselaers pers. comm. to TS). Because IRSNB Av69 is pale brownish, and lacks typical infilled sediment, it is probably not derived from the Bolderian and is more likely from overlying Pleistocene-Holocene deposits, which is supported by the fact that the specimen is indistinguishable from a living species.

Systematic palaeontology

Family ANATIDAE Leach, 1820: Swans, geese, ducks
Subfamily ANSERINAE Leach, 1820: Geese and swans

We retain *A. scaldii* in Anserinae because it possesses the following unique combination of characters: (1) similar proportions, particularly to the smaller *Anser* and *Branta* species; (2) the caudal facies extends as a lamina around the distoventral margin of the *fossa pneumotricipitalis ventralis* (ventral pneumotricipital fossa), partially occluding the fossa and this lamina remains elevated from the base of the fossa and extends under the *tuber. ventralis* (ventral tubercle); (3) the *crista deltopectoralis* (deltoid crest) is concave dorsally and is elongate, extending 37% of its length further distally than the *crista bicipitalis* (bicipital crest); (4) the *tuberculum dorsale* (dorsal tubercle) is elevated above the shaft; (5) there is a prominent capital shaft ridge; (6) the ventral pneumotricipital fossa is highly pneumatic; (7) the ventral tubercle is directed proximally; (8) in cranial view the *capital incisura* (capital groove) forms

a very shallow notch in the proximal profile; and (9) in caudal view the ventral margin from the ventral tubercle around the bicipital crest is evenly convex.

The humeri of Anhimidae and Anseranatidae differ markedly as follows: capital shaft ridge strongly directed towards the head; dorsal pneumotricipital fossa obsolete; lamina around the distoventral margin of the ventral pneumatic fossa (character 2) larger, partially occluding the fossa; ventral pneumatic fossa comparatively smaller; distal extent of entepicondyle less than dorsal condyle; distinct dorsal supracondylar prominence; and external tricipital groove lacking. The humeri of *Dendrocygna* differ markedly in having a prominent capital shaft ridge directed towards the head and a prominent dorsal supracondylar prominence. The pneumatic ventral pneumotricipital fossa distinguishes *A. scaldii* from the non-pneumatic state in *Thalassornis*, *Oxyura*, *Biziura*, *Malacorhynchus*, some Mergini e.g. *Somateria*, *Melanitta*, *Clangula*, *Bucephala*, and some Aythyini. The Tadornini, although having similar proportions, differ in character 2, with the distoventral lamina merging with the floor in the ventral half of the ventral pneumatic fossa. Tadornini further differ in the configuration of the ventral margin of the bicipital crest. In *A. scaldii* this is evenly convex and extends ventrally of the ventral tubercle, as in Anserini, but in Tadornini (*Tadorna*, *Alopochen*, *Cyanochen*) the ventral tubercle is more prominent ventrally, so that when the humerus is viewed in a proximocaudal direction, the ventral margin either forms a straight edge parallel to the capital shaft ridge, or it has a shallow notch distal of the ventral tubercle. Presence of a capital shaft ridge, elevated dorsal tubercle, and the dorsally concave deltoid crest, as in Anserini and Tadornini, are all plesiomorphic states relative to those seen in Anatini (no ridge, tubercle not elevated, deltoid crest flat or convex dorsally). Also, all Anatini possess a marked notch formed by the capital groove in the profile of the proximal end.

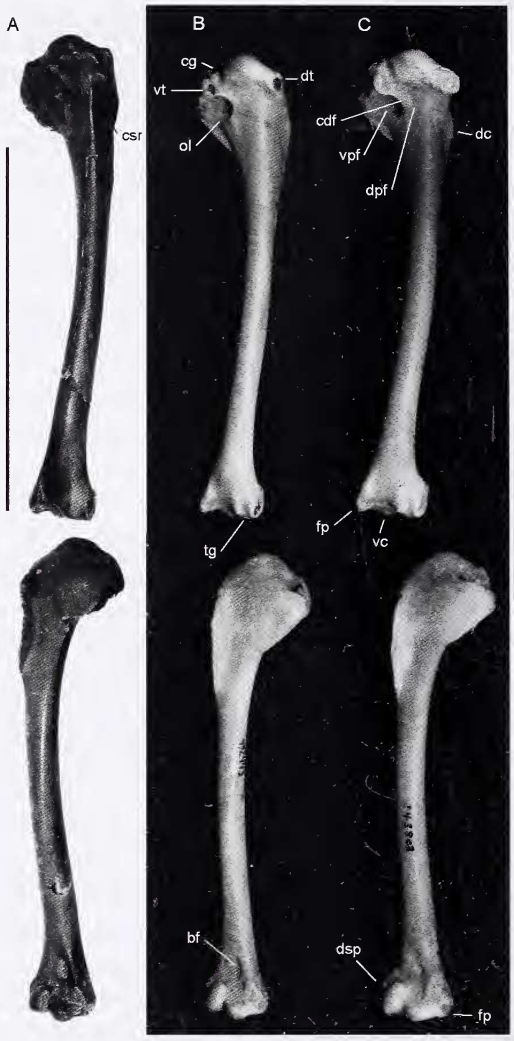

Figure 1. Humeri in caudal view. A. *Anser scaldii* IRSNB Av69; B. *Branta bernicla* USNM 492443; C. *B. leucopsis* USNM 343808. The figured *B. bernicla* humerus is the largest specimen in USNM and that of *B. leucopsis* the smallest, showing the near size continuum of these taxa. *B. leucopsis* is from a zoo bird and has a little pathological deformation notably of the dorsal tubercle. *Anatomical abbreviations*.—bc, bicipital crest; bf, brachial fossa; cdf, crus dorsale fossa (median crest); cg, capital groove; csr, capital shaft ridge; dc, deltoid crest; dpf, dorsal pneumotricipital fossa; dsp, dorsal supracondylar prominence; dt, dorsal tubercle; fp, flexor process; ol, osseus lamina; tg, scapulotricipital groove; vc, ventral condyle; vpf, ventral pneumotricipital fossa; vt, ventral tubercle. Scale bar = 10 cm.

Genus *Branta* Scopoli, 1769

Amongst Anserinae, *A. scaldii* is referred to *Branta* by the following characters. Swans (Cygnini) have much more elongate humeri. Amongst osteological characters, most obvious is the orientation of the capital shaft ridge towards the ventral side of the dorsal tubercle, a derived feature relative to most Anserinae (*Cygnus*, *Anser*), in which the capital shaft ridge is directed towards the head. In *Anser*, the ridge intercepts the middle of a line connecting the distal end of the median crest and the dorsal tubercle, whereas in *A. scaldii* and *Branta*, the ridge passes dorsal to the midpoint of such a line. Thus, in *Branta* the dorsal pneumotricipital fossa is relatively wider. Moreover, as the capital ridge passes towards the head in *Anser*, it forms the ventral side of a distinct groove between itself and the dorsal tubercle: the orientation of the capital ridge towards the immediate ventral side of the dorsal tubercle prohibits such a groove in *Branta*. In *A. scaldii*, the external tricipital groove is present caudally and extends around the distal end as a shallow groove, much like that in *Branta*. The external tricipital groove is present caudally but does not continue around the distal end in *Anser*. *A. scaldii* has a small, indistinct, separate dorsal supracondylar prominence distinct from the dorsal epicondyle. In most Anserinae this is prominent, but is small in *A. caerulescens*, *Branta bernicla* and *B. canadensis*. *A. scaldii* possesses an elongate entepicondyle (flexor process), unlike in *Cygnus* and *B. canadensis* where the entepicondyle has less distal extent than the dorsal condyle. But in other Anserinae, notably smaller taxa such as *Branta bernicla*, *Anser erythropus* and *A. caerulescens*, the entepicondyle has similar distal extent to the dorsal condyle as in *A. scaldii*.

In northern Europe, the species of *Branta* most similar to *A. scaldii* are *B. bernicla* and *B. leucopsis*, both of which overwinter in countries around the southern North Sea, including Belgium (Kear 2005). *B. leucopsis* is the larger (Kear 2005), which is reflected in measurements of humeri (Table 1). Humeri of *B. leucopsis* have significantly more robust proximal and distal ends than *B. bernicla* (t-Test assuming unequal variances: PW, t-Statistic = 3.87107, P(T<=t) two-tail = 0.012, t Critical two-tail = 2.570; DW, t-Statistic = 2.9359, P(T<=t) two-tail = 0.032, t Critical two-tail = 2.570582). As the length ranges of these two species in the small available samples nearly abut, the value for *A. scaldii* could fall in the expected range of either taxon, and the value for SW meets this expectation. The values for PW and DW are within the range of *B. bernicla* and outside that of *B. leucopsis*; importantly relative DW of the two species does not overlap and that for *A. scaldii* falls within that of *B. bernicla*. These observations support referring *A. scaldii* to *B. bernicla*, albeit a large individual, rather than *B. leucopsis*.

TABLE 1

Measurements (mm) for *Branta leucopsis* and *B. bernicla*: data given as mean (range), standard deviation. Specimens measured listed in Methods. DW%L is width of distal; width as percentage of length. PW includes deltoid crest.

	Length	Max. PW	SW	Max. DW	DW%L
B. leucopsis	132.6 (129.6–139.2),	29.8 (28.0–32.0),	8.8 (8.3–9.6),	19.6 (18.7–20.5),	14.7 (14.3–15.4),
(*n*=5)	3.90	1.90	0.59	0.82	0.54
B. bernicla	118.9 (111.8–128.2),	26.3 (24.1–27.9),	7.8 (7.1–8.6),	16.6 (15.6–17.9),	14.0 (13.2–14.3),
(*n*=15)	5.76	1.10	0.45	0.67	0.34
Anser scaldii	129.7	27.2	8.5	17.7	13.6

We therefore synonymise *A. scaldii* Lambrecht, 1933 with *B. bernicla* (Linnaeus, 1758) as follows:

Branta bernicla (Linnaeus, 1758)
Anser scaldii Van Beneden, 1872: 288—*nomen nudum*
Anser Scaldii Van Beneden, 1873: 372—*nomen nudum*
Anser scaldii 'Van Beneden, 1873': Dollo 1909: 19: 116—*nomen nudum*
Anser scaldii '(Van Beneden, 1872)' Lambrecht 1933: 368—new synonymy
Anser Scaldii '(van Beneden)': Gaillard 1939: 78.
Anser scaldii '(Van Beneden, 1872)': Brodkorb 1964: 212; Howard 1964: 267
Anser scaldii '(Van Beneden, 1871)': Bochenski 1997: 40, 304
Anser scaldii Lambrecht: Mlíkovský 2002: 125

Acknowledgements

We thank Philippa Horton (SAM) for access to comparative specimens and facilitating loans, Richard Smith (RBINS) for the cast of *A. scaldii*, Robert Palmer (ANWC), Joanne Cooper (BMNH), Paul Scofield (CM), Rory O'Brien (MV), Alan Tennyson (MNZ) for access to comparative material, and Gerald Mayr (SMF) for providing measurements.

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